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Simulations of Laser Imprint for Nova and Vulcan Experiments and for Ignition Capsules*

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In direct drive ICF, nonuniformities in laser illumination seed ripples at the ablation front in a process called “imprint”. These nonuniformities grow during the capsule implosion and can penetrate the capsule shell, impede ignition, or degrade burn. We have simulated imprint for several recent experiments performed on the Nova laser at LLNL and on the Vulcan laser at Rutherford Lab. These experiments examined a variety of beam smoothing conditions. Most used laser intensities similar to the early part of an ignition capsule pulse shape, $I \cong 10^{13}\ \mathrm{W/cm^2}$. In most cases, the simulations matched the imprint modulation measured in the experiments, although some discrepancies remain. We have also simulated imprint upon National Ignition Facility (NIF) direct drive ignition capsules. We will show simulated imprint amplitudes and resulting shell modulation though the course of the implosion. SSD with 0.5 THz bandwidth is predicted to give an imprint modulation amplitude comparable to an intrinsic surface finish of ~40 nm rms. Imprinted modulation is treated as an equivalent surface finish for the purpose of addressing the modulation growth through the implosion and stagnation of the capsule shell. One method of examining modulation growth is the Haan model, where linear growth factors as a function of spherical harmonic mode number are obtained from an analytic dispersion relation. Ablation front amplitudes are predicted to become substantially nonlinear, so that saturation corrections are large. We have also performed direct numerical simulations of two-dimensional multimode growth using LASNEX. This analysis may be used to set beam smoothing requirements for the NIF laser.

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